Circulation Of Marginal And Semi-Enclosed Seas
(Sea Of Japan And Related Process Studies)

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LONG-TERM GOAL

My long-term goal is to understand the circulation dynamics of marginal and semi-enclosed seas through numerical simulation. Understanding the weather-driven transient flows (especially in coastal regions), mesoscale variability, ventilation, seasonal and interannual variability, and flow interactions with the basin topography are part of this goal.

OBJECTIVES

I wish to determine the "necessary and sufficient" conditions for usefully accurate numerical simulations, which requires attention to model evaluation using observations as well as other models. For example, the oceanographic community has yet to establish the space-time resolution and amplitude accuracy requirements for atmospheric forcing of marginal and semi-enclosed seas. Given the difficulty of determining, in particular, open (lateral) boundary conditions, it is anticipated that data assimilation will be required.

APPROACH

We are using the Princeton Ocean Model (POM) as implemented on a mesoscale-admitting grid (ca. 10 km. resolution) and with 26 sigma levels (and with relatively high, logarithmic resolution in the surface and bottom boundary layers) for the Japan (East) Sea (JES). It is driven with surface windstress, heat flux, and moisture flux, and with specified throughflow from the Korean/Tsushima Strait to Tsugaru and Soya Straits. The model output is compared to available data, especially CREAMS I current meter data (from Prof. Masaki Takematsu, Kyushu U.) over the Japan Basin. I aim to create and analyze a test dataset by simulating the CREAMS II field experiment before the fieldwork is completed, and to later conduct model evaluations and data assimilation with the CREAMS II observations.

WORK COMPLETED

Model simulations with climatological monthly wind-forcing were made and compared with climatological mean wind-forcing simulations and CREAMS I current meter data.

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Preliminary model runs made with NSCAT, ECMWF, and MM5 (from Dr. Shuyi Chen, RSMAS) synoptic atmospheric forcing for Siberian cold air outbreaks and their associated atmospheric cyclones were further analyzed.

Plans have been advanced, together with several other American, Japanese, Korean, and Russian JES modelers, for coordinating model-model and model-observations comparisons with CREAMS I and II observations.

As Co-Chair of PICES Working Group 10, a draft report and modern bibliography were revised; they cover the circulation and ventilation of the JES and adjacent waters.

RESULTS

Comparisons of the simulated velocities from cases with climatological (Na) monthly wind-forcing and climatological (Na) mean wind-forcing (constant throughflow-forcing and relaxation to climatological mean surface temperatures and salinities were used in both cases) versus CREAMS I current observations at 1,100; 2,100; and 3,000m over the Japan Basin (in a water depth of 3,500m) for 1,100 days indicate that at all three levels:

- the monthly forcing produces weaker mean velocities than mean forcing, in closer agreement with observed values

- the monthly forcing produces more energetic motions in the mesoscale band (10 to 100 days) than mean forcing, again in closer agreement with observed values

- the monthly forcing produces a more energetic submesoscale band (1 to 10 days)and agrees well with observed values

- the monthly forcing produces a stronger near-inertial peak that is nearly as energetic as observed values

- time series plots indicate seasonal modulaton of the mesoscale variability in the monthly wind-forcing case that is similar to that observed

- in both simulation cases, there was vertically coherent mesoscale variability (due to the dominance of low order vertical modes) that was peaked at a period of 50 days and mid-depth (as in the observed variance); with monthly forcing, there were indications of bottom-trapping.

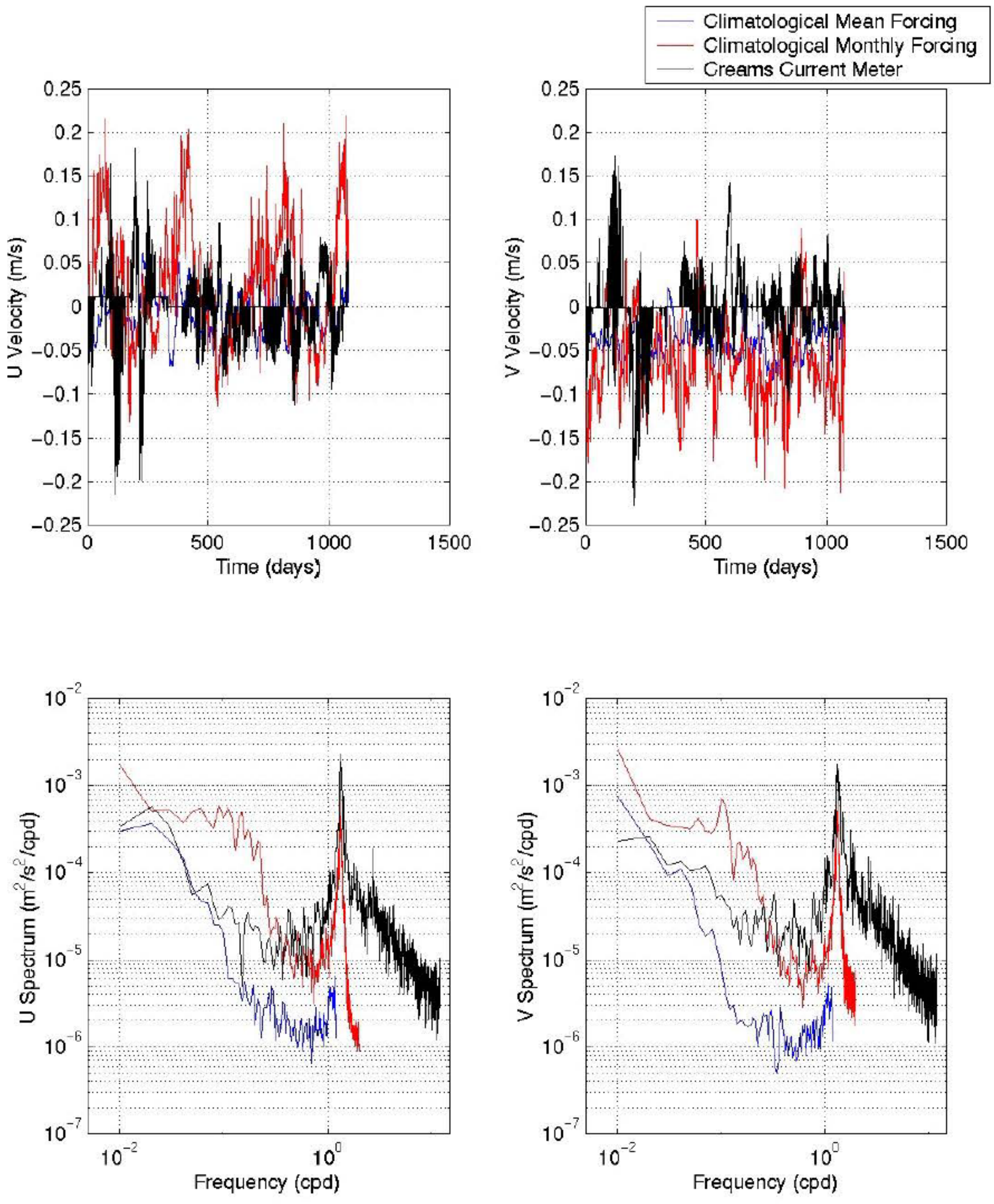
Yet to be determined is how synoptic wind-forcing and/or thermohaline forcing will further alter the level of agreement with observed currents.

[NOTE: the enclosed figure only shows results for 2,100m; however, they are nearly identical to those at 1,100 and 3,000m due to the dominance of low order vertical modes. The spectra have different Nyquist frequencies because the archival rate for the simulations differed in each case and with the observational sampling rate.]

IMPACT/APPLICATIONS

The analysis of our simulations indicates the importance of ca. 3-hourly observed and model time series of at least two-years duration for describing the variability in the mesoscale and sub-mesoscale spectral bands. Similarly, the importance of observations and simulations at 10 or more levels spanning the entire water column for describing the vertical structure of the dominant mesoscale variability is indicated.

Comparison for Station S5/M3 at ~2100m



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